

What Is Claimed Is:

1. A data transformation module adapted to transform requested data that flows between a client and a server comprising:

5 a plug-in module adapted to be integrated with a computing node located between the client and the server, the plug-in module adapted to monitor a data flow between the client and the server for at least one inference point, wherein the plug-in module generates a query in response to the at least one inference point, wherein the data flow includes requested data;

10 a plurality of data transformation service modules each adapted to provide at least one data transformation service adapted to transform the requested data into transformed data;

15 an inference engine associated with the plug-in module and the plurality of data transformation modules; and

20 a knowledge base associated with the inference engine, wherein the knowledge base includes data and rules for making a transformation decision, wherein the rules are segmented with respect to a selected inference point such that only selected rules are applicable to the selected inference point,

25 wherein the inference engine receives the query from the plug-in module in response to the at least one inference point, and wherein for each particular inference point the inference engine examines the knowledge base to determine whether at least one action is to be performed at the at least one inference point.

30 2. A data transformation module as recited in Claim 1, wherein the at least one action is to be performed and wherein the at least one action comprises determining selected ones of the data transformation service modules that are applicable in a certain context to transform the requested data into transformed data.

35 3. A data transformation module as recited in Claim 2, wherein the at least one action is to be performed and wherein the at least one action further comprises determining an order in which appropriate ones of the data transformation service modules are to be applied to transform the requested data.

4. A data transformation module as recited in Claim 2, wherein the inference engine examines only the selected rules and data relevant to those selected rules in determining at least one data transformation service to perform.

5 5. A data transformation module as recited in Claim 4, wherein the knowledge in the knowledge base includes content adaptation parameters and content adaptation service rules used to determine whether the at least one action is to be performed, wherein the selected rules comprise selected ones of the content adaptation service rules associated with a particular inference point.

10 6. A data transformation module as recited in Claim 5, wherein the content adaptation parameters include a database of supported user agents, a database of URLs that are not transformed, a database of available CA services including service constraints and service parameters of each CA service, a database of CA service level specifications for services configured in several different levels, a database of service exception rules that specify exceptional cases when services are not applied, a database of available text transformation scripts and associated constraints, and a database of MIME types and associated file suffixes.

15 20 7. A data transformation module as recited in Claim 6, wherein the content adaptation service rules determine the applicability of a particular service module, wherein the content adaptation service rules each include zero or more constraints associated with the content adaptation service rule, wherein a particular content adaptation service rule is applicable only if all constraints associated with that rule are satisfied and no exception rules 25 associated with that service are triggered, and wherein selected ones of the content adaptation service rules are associated with each inference point such that only the selected ones of the content adaptation service rules are evaluated at a particular inference point.

8. A data transformation module as recited in Claim 7, wherein at a particular inference point, the inference engine examines the knowledge base to determine whether service-independent preconditions, constraints of applicable content adaptation service rules, and content adaptation parameters are satisfied, and the inference engine applies service composition logic in order to decide in which order services should be applied in case multiple services are applicable.

9. A data transformation module as recited in Claim 1, wherein the at least one inference point defines states and events in the computing node, wherein the query is generated based on a state of a particular inference point, and wherein the at least one inference point comprises a plurality of inference points.

10. A data transformation module as recited in Claim 1, wherein the at least one inference point causes the inference engine to determine that zero or more of the data transformation service modules applicable in a given context.

11. A data transformation module as recited in Claim 7, wherein the inference engine is adapted to issue a message indicating why selected ones of the plurality of data transformation service modules are to be applied at specified times.

12. A data transformation module as recited in Claim 1, wherein the at least one action is to be performed and wherein the at least one action comprises application of a plurality of data transformation service modules to transform the requested data into transformed data.

13. A data transformation module as recited in Claim 12, wherein the plurality of data transformation service modules is scalable such that new data transformation service modules may be added.

14. A data transformation module as recited in Claim 1, wherein the at least one action is to be performed and wherein the at least one action comprises monitoring the requested data.

5 15. A data transformation module as recited in Claim 7, wherein the requested data comprises WWW content, and wherein each data transformation module is adapted to be integrated with at least one of a plurality of computing nodes through which HTTP requests and responses travel.

10 16. A data transformation module as recited in Claim 1, wherein the plug-in module is adapted to be coupled to a proxy server to monitor HTTP traffic for events and to notify the inference engine when inference points are encountered.

15 17. A data transformation module as recited in Claim 1, wherein the inference engine is a logic-based inference engine, and wherein the knowledge base is extensible.

20 18. A data transformation module as recited in Claim 1, wherein the at least one action is to be performed and wherein the at least one action comprises routing of the requested data.

19. A data transformation module as recited in Claim 18, wherein a stored copy of transformed data is sent to the client when the requested data has previously been transformed.

20. A method of transforming requested data that flows between a client and a server comprising:

providing a knowledge base that includes service rules, wherein specific service rules are associated with particular inference points;

5 monitoring data flowing between a client and a server for an event;

invoking an inference engine when an inference point is encountered; and

10 examining a knowledge base to determine selected ones of a plurality of data transformation services that are applicable in a certain context to transform the requested data into transformed data, wherein the service rules examined are the specific service rules associated with the inference point encountered.

21. A method of transforming requested data recited in Claim 20, further comprising:

15 transforming the requested data by applying selected ones of the plurality of data transformation services to the requested data.

22. A method of transforming requested data recited in Claim 20, further comprising:

20 applying the selected ones of a plurality of data transformation services to the requested data to transform the requested data into transformed data.

23. A method of transforming requested data recited in Claim 20, further comprising:

25 if more than one data transformation service is applicable, determining an order in which the applicable data transformation services should be performed.

24. A method of transforming requested data recited in Claim 20, further comprising:

30 generating a message responsive to why a particular data transformation service is applicable for transforming the requested data into transformed data.

25. A method of transforming requested data recited in Claim 20, wherein monitoring data flowing between a client and a server for an event comprises:
identifying an inference point in state machines of an intermediary node and a plug-in module.

26. A method of transforming requested data recited in Claim 20, wherein invoking an inference engine when an inference point is encountered comprises:
issuing queries to the inference engine when an inference point is encountered.

27. A method of transforming requested data requested by a client, comprising:
defining inference points;
invoking an inference engine when an inference point is encountered;
determining applicable data transformation services at a particular inference point;
computing parameters required for invocation of the applicable data transformation services; and

if parameters required for invocation of the applicable data transformation services are successfully computed, applying the applicable data transformation services to the requested data to transform the requested data into transformed data.

28. A system adapted to transform requested data that flows between a client and a server into transformed data, comprising:

means for providing service rules, wherein specific service rules are associated with particular inference points;

means for monitoring data flowing between a client and a server and calling means for inferencing when an inference point is encountered; and

wherein means for inferencing is adapted to examine the knowledge to determine selected data transformation services of a plurality of data transformation services, wherein only the specific service rules are examined.

29. A system adapted to transform requested data recited in Claim 28, further comprising:
means for transforming the requested data by applying selected ones of the plurality of data transformation services to the requested data.

30. A system adapted to transform requested data recited in Claim 28, further comprising:
means for applying the selected ones of a plurality of data transformation services to the requested data to transform the requested data into transformed data.

31. A system adapted to transform requested data recited in Claim 28, further comprising:
means, if more than one data transformation service is applicable, for determining an order in which the applicable data transformation services should be performed.

32. A system adapted to transform requested data recited in Claim 28, further comprising:
means for generating a message responsive to why a particular data transformation service is applicable for transforming the requested data into transformed data.

33. A system adapted to transform requested data recited in Claim 28, wherein means for monitoring data flowing between a client and a server for an event, comprises:
means for identifying an inference point in state machines of an intermediary node and a plug-in module.

34. A system adapted to transform requested data recited in Claim 28, wherein calls to the inference engine when an inference point is encountered comprise queries to the inference engine when an inference point is encountered;

35. A system adapted to transform data requested by a client, comprising:

means for monitoring data flowing between a client and a server for an event, wherein the means for monitoring calls an inference engine when an inference point is encountered;

means for determining applicable data transformation services at a particular inference point and computing parameters required for invocation of the applicable data transformation services;

means for applying the applicable data transformation services to transform the requested data into transformed data, if the parameters are successfully computed; and
means for sending the transformed data to a client.

36. A computer network, comprising:

a server that includes data;

a client that requests data from the server;

a computing node located between the client and the server, wherein the computing node includes at least one inference point associated therewith, wherein each inference point has at least one content adaptation service rule associated therewith; and

a data transformation module adapted to transform requested data that flows between a the client and the server into transformed data, the at least one data transformation module integrated with the computing node.

37. The computer network according to Claim 36, the data transformation module comprising:

5 a plug-in module adapted to be integrated with a computing node located between the client and the server, wherein the plug-in module is adapted to monitor a data flow between the client and said server for at least one inference point, wherein the plug-in module generates a query in response to the at least one inference point, wherein the data flow includes requested data;

10 a plurality of data transformation service modules each adapted to provide at least one data transformation service to transform the requested data into transformed data;

15 an inference engine associated with the plug-in module and the plurality of data transformation modules; and

a knowledge base associated with the inference engine, wherein the knowledge base includes rules and data relevant to the rules for making a transformation decision, wherein the rules are segmented with respect to a selected inference point such that only selected rules are applicable to the selected inference point,

wherein the inference engine receives the query from the plug-in module in response to the at least one inference point, and examines the knowledge base to determine whether at least one action is to be performed at the at least one inference point.

20 38. The computer network according to claim 36, wherein the computing node comprises a caching proxy server.

39. The computer network according to claim 36, wherein the computing node comprises the client.

40. The computer network according to claim 36, wherein the computing node comprises the server.

41. A computer network, comprising:

at least one server that includes data;

at least one client that requests data from the server;

a plurality of computing nodes located between the client and the server, wherein each

5 computing node includes at least one inference point associated therewith, wherein each inference point has at least one content adaptation service rule associated therewith; and

a plurality of data transformation modules adapted to transform requested data that flows between the client and the server into transformed data, each of the data transformation modules adapted to be integrated with at least one of the plurality of the computing nodes.

42. The computer network according to Claim 41, wherein each of the data transformation modules comprises:

a plug-in module adapted to be integrated with a computing node located between the client and the server, wherein said plug-in module is adapted to monitor a data flow between said client and said server for at least one inference point, wherein the plug-in module generates a query in response to the at least one inference point, wherein the data flow includes requested data;

a plurality of data transformation service modules each adapted to provide at least one data transformation service to transform the requested data into transformed data;

20 an inference engine associated with the plug-in module and the plurality of data transformation modules; and

a knowledge base associated with the inference engine, wherein the knowledge base includes rules and data relevant to the rules for making a transformation decision, wherein the rules are segmented with respect to a selected inference point such that only selected rules are
25 applicable to the selected inference point,

wherein the inference engine receives the query from the plug-in module in response to the at least one inference point, and examines the knowledge base to determine whether at least one action is to be performed at the at least one inference point.

43. The computer network according to Claim 41, wherein data transformation modules are coupled to selected ones of the plurality of computing nodes, such that the requested data is transformed at each of the selected ones of the plurality of nodes.

5 44. The computer network according to Claim 41, wherein one of the computing nodes comprises a caching proxy server.

45. The computer network according to Claim 41, wherein one of the computing nodes comprises the client.

10 46. The computer network according to Claim 41, wherein one of the computing nodes comprises the server.

15 47. The method of transforming requested data that flows between a client and a server, comprising:

monitoring data for an inference point;

issuing a query to an inference engine in response to an inference point;

performing an inferencing process to determine a list of applicable data

transformation services and an order in which the applicable data transformation services should be executed; and

20 if at least one applicable data transformation service is found, applying the applicable data transformation services to the requested data in the order determined by the inference engine to transform the requested content into transformed content.

25 48. The method of transforming the requested data recited in Claim 47, further comprising:

sending the transformed content to a user agent.

49. A method of transforming the requested data as recited in Claim 47, wherein performing an inferencing process to determine a list of applicable data transformation services comprises:

checking service independent constraints of each applicable data transformation
5 service;
checking service specific constraints of each applicable data transformation service;
computing service parameters of each applicable data transformation service; and
performing service composition to determine the order in which the applicable data
transformation services should be executed.

50. A method of transforming the requested data as recited in Claim 49, wherein checking service independent constraints comprises:

determining whether all service independent constraints of each applicable data
transformed service are satisfied at a particular inference point.

51. A method of transforming the requested data as recited in Claim 49, wherein checking service specific constraints comprises:

determining all potentially applicable data transformation services;
determining whether the service specific constraints for each potentially applicable
20 data transformation service are satisfied.

52. A method of transforming the requested data as recited in Claim 51, wherein determining whether the service specific constraints for each potentially applicable data transformation service are satisfied comprises:

determining whether service parameters required for invocation of each data
25 transformation service can be successfully computed.

53. A method of transforming the requested data as recited in Claim 49, wherein for those data transformation services whose service parameters needed for invocation have
30 been successfully computed, the step of performing service composition comprises:

arranging the data transformation services in logical order.

54. A data transformation module adapted to transform requested data that flows between a client and a server into transformed data, comprising:

a plug-in module adapted to be integrated with a computing node located between the client and the server, wherein said plug-in module is adapted to monitor a data flow between said client and said server for at least one inference point, wherein the plug-in module generates a query in response to the at least one inference point, wherein the data flow includes requested data;

a plurality of data transformation service modules each adapted to provide at least one data transformation service to transform the requested data into transformed data; and

a content adaptation logic module associated with the plug-in module and the plurality of data transformation modules, wherein the content adaptation logic module includes data and rules for making a transformation decision, wherein the rules are segmented with respect to a selected inference point such that only selected rules are applicable to the selected inference point, and wherein the content adaptation logic module receives the query from the plug-in module in response to the at least one inference point, and wherein for each particular inference point the content adaptation logic module determine whether at least one action is to be performed at the at least one inference point.

55. A data transformation module as recited in Claim 54, wherein the content adaptation logic module comprises:

an inference engine associated with the plug-in module and the plurality of data transformation modules; and

a knowledge base associated with the inference engine, wherein the knowledge base includes data and rules for making a transformation decision, wherein the rules are segmented with respect to a selected inference point such that only selected rules are applicable to the selected inference point,

wherein the inference engine receives the query from the plug-in module in response to the at least one inference point, and wherein for each particular inference point the inference engine examines the knowledge base to determine whether at least one action is to be performed at the at least one inference point.

56. A data transformation module as recited in Claim 54, wherein the at least one action is to be performed and wherein the at least one action comprises determining selected ones of the data transformation service modules that are applicable in a certain context to transform the requested data into transformed data.

57. A data transformation module as recited in Claim 56, wherein the at least one action is to be performed and wherein the at least one action further comprises determining an order in which appropriate ones of the data transformation service modules are to be applied to transform the requested data.

58. A data transformation module as recited in Claim 56, wherein the inference engine examines only the selected rules and data relevant to those selected rules in determining at least one data transformation service to perform.

59. A data transformation module as recited in Claim 58, wherein the knowledge in the knowledge base includes content adaptation parameters and content adaptation service rules used to determine whether the at least one action is to be performed, wherein the selected rules comprises selected ones of the content adaptation service rules associated with a particular inference point.

60. A data transformation module as recited in Claim 59, wherein the content adaptation service rules determine the applicability of a particular service module, wherein the content adaptation service rules each include zero or more associated constraints with the content adaptation service rule, wherein a particular content adaptation service rule is applicable only if all constraints associated with that rule are satisfied and no exception rules associated with that service are triggered, and wherein selected ones of the content adaptation service rules are associated with each inference point such that only the selected ones of the content adaptation service rules are evaluated at a particular inference point.

61. A data transformation module as recited in Claim 60, wherein at a particular inference point, the inference engine examines the knowledge base to determine whether service-independent preconditions, constraints of applicable content adaptation service rules, and content adaptation parameters are satisfied, and applies service composition logic in order to decide in which order services should be applied in case multiple services are applicable.

62. A data transformation module as recited in Claim 54, wherein the at least one data transformation service module is selected from a plurality of data transformation modules and wherein the plurality of data transformation modules each adapted to provide at least one transformation service, comprise:

a plurality of data transformation service modules associated with the plug-in module and the inference engine, wherein each of the plurality of data transformation service modules is adapted to perform at least one data transformation of a plurality of data transformations on the requested data, and wherein selected ones of the plurality of data transformation service modules are applied to transform the requested data.

63. A data transformation module as recited in Claim 54, wherein the at least one action is to be performed and wherein the at least one action comprises application of a plurality of data transformation service modules to transform the requested data into transformed data.

64. A data transformation module as recited in Claim 54, wherein the at least one action is to be performed and wherein the at least one action comprises monitoring the requested data.

65. A data transformation module as recited in Claim 54, wherein the at least one action is to be performed and wherein the at least one action comprises routing of the requested data.